A Tale of Two Tapes: Broselow-Luten Tapes, 2011 vs. 2017

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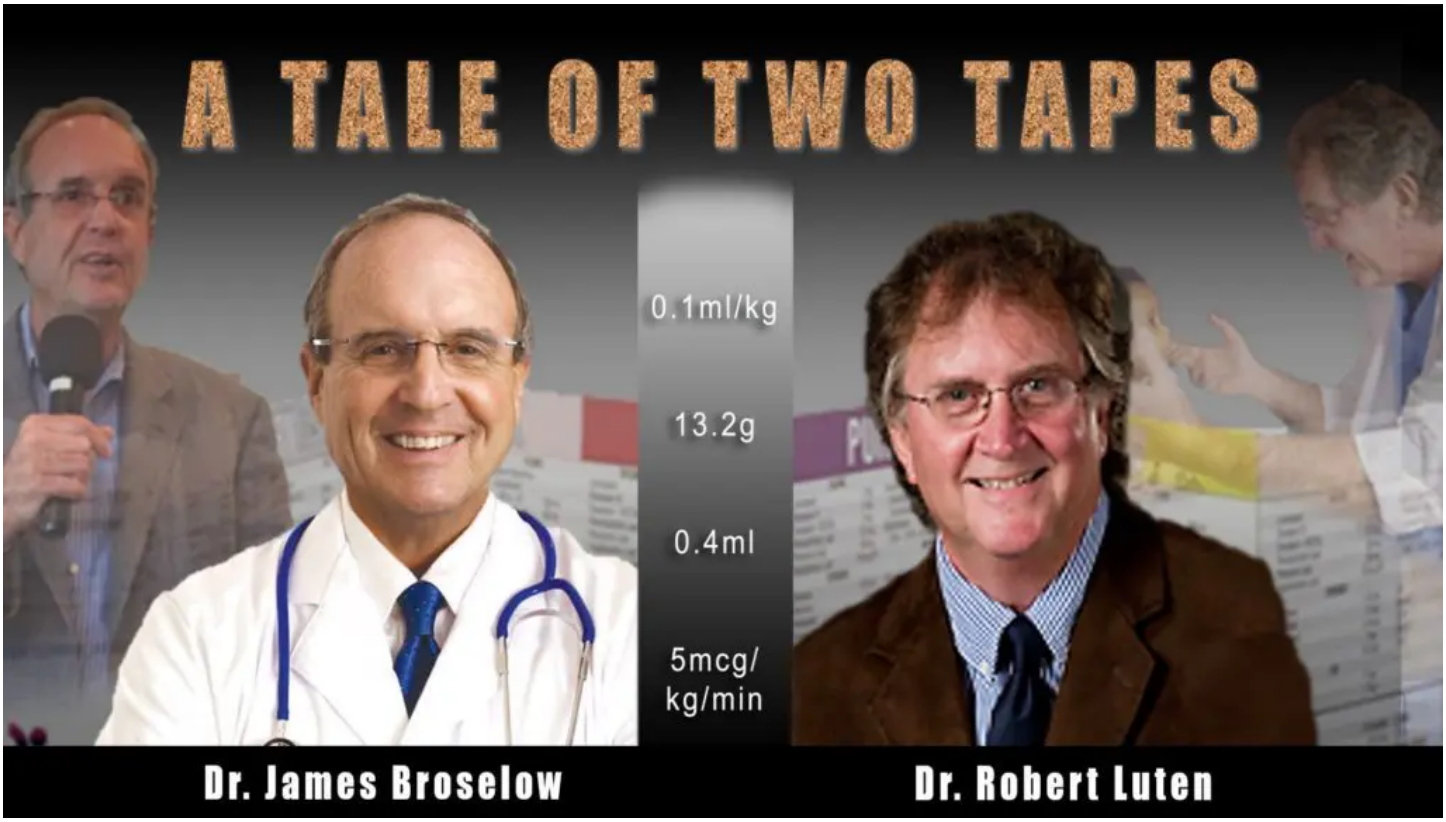


If you began your healthcare career when disco ruled the airwaves, you probably had the distinctly unpleasant–and possibly frightening–experience of pediatric emergency care ruled by guesswork: How much does the patient weigh so you can calculate how much of each drug to administer? What amount of fluid should be infused? What size endotracheal tube is needed? There were so many questions and no easy way to find the answers. And making matters worse, there was no time to waste! We need to act *now*!

But that was the mid-1980s, and as our disco balls went into storage (only ever to be seen again for the occasional theme party), a revolutionary tool for pediatric care was introduced: the Broselow tape. Created by emergency medicine physician Jim Broselow, MD, and pediatric emergency medicine physician Robert Luten, MD, the Broselow tape established a worldwide standard for managing the emergency care of pediatric patients using a length-based system of color-coded zones.[1]

Although using the tape isn't a complex task, proficiency doesn't come automatically. Regular review

and practice are needed to properly use this innovative tool in a highly stressful pediatric medical emergency.

You should be ready to answer a few, basic questions: Where do I find the tape? What information is on it? How do I properly use it?

Ideal Body Weight and "What If"

We were understandably excited with the concept of length-based resuscitation guidelines, but our training and experience has taught us to question just about everything. So naturally, we wondered what to do when faced with a child whose size and body proportions fell outside of what we would typically consider average.

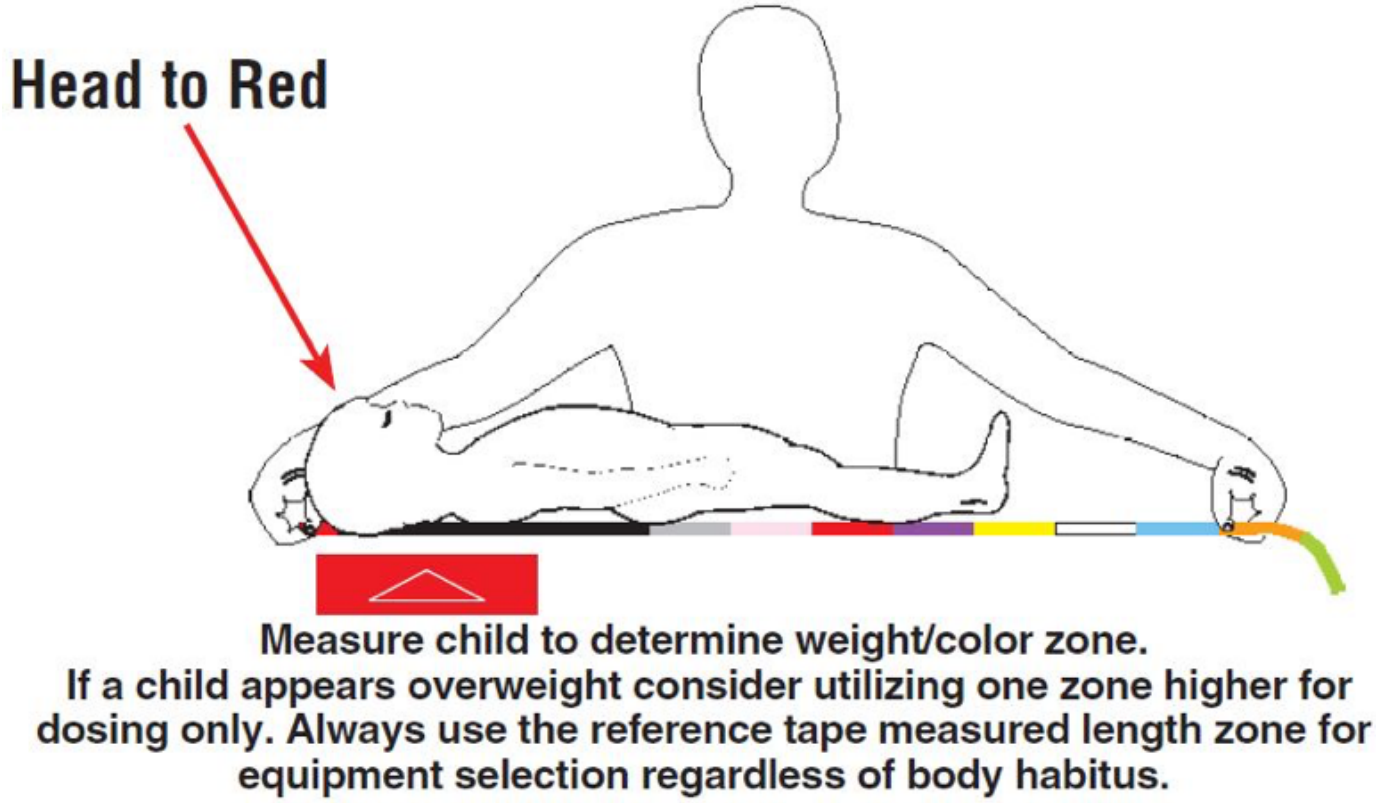
Put quite bluntly, what do we do with an obese or emaciated child? Lacking specific guidance on the subject, we often made our own rules or followed the great myth of "just bump it up a color."

The good news, according to Luten, is that pediatric emergency drugs–with the exception of amiodarone and succinylcholine–are based on ideal body weight.[2] Ideal body weight is the weight that's determined from the length (i.e., height) of the child. Drugs like epinephrine, dopamine, morphine, fentanyl and ketamine are based on what a child should *ideally* weigh.

There are exceptions. If a child is far above any growth chart expectations, the tape reminds us to bump up a color based on what we believe is appropriate, and what protocols or orders allow.

An important consideration when exercising this exception is to only bump up one color for medication dosages, *not* for equipment. A child who gains weight doesn't typically increase the size of their airway; it should remain the same regardless of whether the child is skinny or husky.[2,3] (See Figure 1.)

Figure 1: "Head to red" and obesity adjustment reminders on Broselow-Luten tape
Image courtesy Armstrong Medical



What if circumstances make it either impractical or impossible to measure your pediatric patient? The tape can still be of immense value if you have an actual or approximate age. In addition to using length, age can also be used to identify the appropriate color code for medications and equipment. (See Figure 2.)

Figure 2: Broselow-Luten color zones and age/weight chart (download here**)**
Image courtesy Armstrong Medical

Broselow®-Luten Zones

It is *always preferable* to measure the patient using a Broselow® Pediatric Emergency Reference Tape to determine the color zone.

For situations in which the child cannot be measured, patient age may be used to select the zone.

Zone	Patient weight	Age
3 kg, 4 kg, and 5 kg zones	3 kg, 4 kg, and 5 kg	< 3 mos
Pink	6–7 kg	3–5 mos
Red	8–9 kg	6–11 mos
Purple	10–11 kg	12–24 mos
Yellow	12–14 kg	2 yrs
White	15–18 kg	3–4 yrs
Blue	19–23 kg	5–6 yrs
Orange	24–29 kg	7–9 yrs
Green	30–36 kg	10–11 yrs

Key Points: The 2017 Broselow-Luten Tape

Friends and PALS: The 2017 tape has been updated to reflect the 2015 American Heart Association PALS recommendations.

Can't get an IV: The 2017 tape has a new section labeled "No IV Quick Access Meds Chart," which is located after the green color zone at the end of the tape. This not only addresses anaphylaxis and albuterol dosing, but provides alternative medication routes and dosing for seizures. (See Figure 3.)

Figure 3: No IV Quick Access Meds chart from 2017 Broselow-Luten tape

Image courtesy Armstrong Medical

No IV Quick Access Meds													
mLs		3 Kg	4 Kg	5 Kg	Pink	Red	Purple	Yellow	White	Blue	Orange	Green	DOSE
ANAPHYLAXIS													
IM EPI (1 mg/mL)		0.03 mL	0.04 mL	0.05 mL	0.07 mL	0.09 mL	0.1 mL	0.13 mL	0.17 mL	0.21 mL	0.27 mL	0.33 mL	0.01 mg/kg Max 0.5 mg
Epi Auto-injector		N/A	N/A	N/A	N/A	N/A	0.15 mg	0.15 mg	0.15 mg	0.15 mg	0.3 mg	0.3 mg	10-25 kg: 0.15 mg >25 kg: 0.3 mg
SEIZURES													
Rectal Diazepam 5 mg/mL		0.3 mL	0.4 mL	0.5 mL	0.65 mL	0.85 mL	1 mL	1.3 mL	1.7 mL	2 mL	2 mL	2 mL	0.5 mg/kg Max 10 mg
Nasal & IM Midazolam 5 mg/mL		0.12 mL	0.16 mL	0.2 mL	0.26 mL	0.34 mL	0.42 mL	0.52 mL	0.66 mL	0.84 mL	1 mL	1.3 mL	0.2 mg/kg
WHEEZING													
Albuterol Nebulized	0.83 mg/mL	2.5 mL	2.5 mL	2.5 mL	2.5 mL	2.5 mL	5 mL	5 mL	5 mL	5 mL	5 mL	5 mL	<10 kg: 2.5 mg >10 kg: 5 mg (Dilute the 5 mg/mL in 3 mLs of respiratory saline solution)
	5 mg/mL	0.5 mL	0.5 mL	0.5 mL	0.5 mL	0.5 mL	1 mL	1 mL	1 mL	1 mL	1 mL	1 mL	
DOSE in Milligrams													
IM EPI		0.03	0.04	0.05	0.07	0.09	0.1	0.13	0.17	0.21	0.27	0.33	
Rectal Diazepam		1.5	2	2.5	3.25	4.25	5	6.5	8.5	10	10	10	
Nasal/IM Midazolam		0.6	0.8	1	1.3	1.7	2.1	2.6	3.3	4.2	5	6.5	
Albuterol		2.5	2.5	2.5	2.5	2.5	5	5	5	5	5	5	

Backup/alternate airways: Although a variety of options for infant and pediatric emergency airway management are available, the 2017 tape only includes sizing for laryngeal mask airways (LMAs). Infant and pediatric King airways that were recently introduced have a color-coded label on their package with a suggested Broselow-Luten color zone.

Ventilator settings: The 2017 tape includes a revised legend for initial ventilator settings section, which is located before the gray color zone at the beginning of the tape. This details suggested initial infant and pediatric ventilator settings in a color-coded format. (See Figure 4.)

Figure 4: Legend for initial ventilator settings chart from 2017 Broselow-Luten tape

Image courtesy Armstrong Medical.

LEGEND FOR INITIAL VENTILATOR SETTINGS:

These initial ventilator settings should be adjusted according to clinical state and arterial blood gas monitoring.

Oxygen	100%*					
Tidal volume	6-10 mL/kg					
Tidal volume and Inspiratory time settings	**zone**	**Tid vol (mL)**	**Insp Time (sec)**	**zone**	**Tid vol (mL)**	**Insp Time (sec)**
	3 kg	20-30	0.6	Yellow	80-130	0.7
	4 kg	24-40	0.6	White	100-165	0.7
	5 kg	30-50	0.6	Blue	125-210	0.8
	Pink	40-65	0.6	Orange	160-265	0.8
	Red	50-85	0.6	Green	200-330	0.8
	Purple	65-105	0.7			
Peak inspiratory pressure	20-30 cm H_2O with normal lung compliance (lowest level that gives adequate chest expansion)					
Ventilator rate	Infants: 20-25 breaths/minute Children: 12-25 breaths/minute					
PEEP	3-5 cm H_2O					

Modified from the Textbook of Pediatric Advanced Life Support. American Heart Association

* May initiate ventilation with 100%, but use the lowest inspired oxygen that will maintain arterial oxyhemoglobin saturation of ≥94%.

More dosing by milligrams vs. milliliters: Essential emergency medications have been updated for EMS and ED providers with precalculated doses in milligrams *as well as* milliliters, eliminating the need to do mental math in the middle of a pediatric emergency. This is a very welcome addition; however, it's important to ensure that milligrams are used for weight (i.e., dose of the drug) and milliliters are used for volume (i.e., how much to push).

Tips, Tricks and Translations

Measuring:

Always re-measure and confirm the correct color when the child arrives at the ED.

Measure the child from head to heels, *not* to the toes. If the foot is abnormally flexed or extended, an inaccurate measurement could move the child to a different color zone. And speaking of the head: "Red goes toward the head."

At one end of the tape is a big red arrow. Remember, "red goes toward the head." This is where to start measuring to determine the child's color zone and *approximate* ideal body weight (i.e., what they should weigh). (See Figure 5.)

One tape, two sides: There's vital information on both sides of the tape, so use both sides! (See Figure 6.)

R&R: Resuscitation and rapid sequence intubation (RSI) is on one side and everything else is on the other.

E&E: Epinephrine doses are on one side and endotracheal tube sizes on the other.

Weights are only listed on one side of the tape.

Figure 6: Blue color zone from 2017 Broselow-Luten tape

Image courtesy Armstrong Medical

BLUE

SEIZURE	
Lorazepam (2 mg/mL)	2 mg (1 mL)
(4 mg/mL)	2 mg (0.5 mL)
Diazepam IV (5 mg/mL)	4.2 mg (0.84 mL)
Phenobarbital (65 mg/mL)	420 mg (6.5 mL)
(130 mg/mL)	420 mg (3.2 mL)
Phenytoin (50 mg/mL)	420 mg (8.4 mL)
Fosphenytoin (50 mg PE/mL)	420 mg PE (8.4 mL)
Levetiracetam (100 mg/mL)	1050 mg (10.5 mL)
OVERDOSE/HYPOGLYCEMIA	
$D_{25}W$ (0.25 g/mL)	10.5 g (42 mL)
$D_{50}W$* (0.5 g/mL)	10.5 g (21 mL)
Naloxone (1 mg/mL)	2 mg (2 mL)
(0.4 mg/mL)	2 mg (5 mL)
Flumazenil (0.1 mg/mL)	0.2 mg (2 mL)
Charcoal (25 g/120 mL)	21 g (100mL)
Glucagon (1 mg/mL)	1 mg (1 mL)

ICP	
3% Saline	42-105 mL
Mannitol 20% (0.2 g/mL)	21 g (105 mL)
25% (0.25 g/mL)	21 g (84 mL)
Furosemide (10 mg/mL)	21 mg (2.1 mL)
FLUIDS	
Volume Expansion	
Crystalloid (NS or LR)	420 mL
Colloid/blood	210 mL
Maintenance	
D5 1/2 NS + 20 mEq KCL/L	63 mL/hr
PAIN	
Fentanyl (50 mcg/mL)	21 mcg (0.42 mL)
Morphine (2 mg/mL)	2.1 mg (1.1 mL)
(4 mg/mL)	2.1 mg (0.53 mL)

* Dilute $D_{50}W$ 1:1 with preservative free sterile water

EQUIPMENT	
*E.T. Tube	5.5 Uncuffed/*5.0 Cuffed
E.T. Insertion Length	15.5-16.5 cm
Stylet	10 French
Suction Catheter	10 French
Laryngoscope	2 Straight or Curved
BVM	Child
Oral Airway	70 mm
*Nasopharyngeal Airway	24 French
*LMA	2-2.5

EQUIPMENT	
Oxygen Mask	Pediatric NRB
*$ETCO_2$	Adult
*Urinary Catheter	10-12 French
*Chest Tube	24-28 French
NG Tube	12-14 French
Vascular Access	18-20 Ga
Intraosseous (IO)	15 Ga
BP Cuff	Child

*May not be included in Organizer System(s).

BLUE

RESUSCITATION	
Epinephrine (1:10,000)	0.21 mg (2.1 mL)
Epinephrine ET (1:1,000)	2.1 mg (2.1 mL)
Atropine (0.1 mg/mL)	0.42 mg (4.2 mL)
Atropine ET (0.4 mg/mL)	1 mg (2.5 mL)
Sodium Bicarbonate 8.4%	21 mEq (21 mL)
Lidocaine 2% (20 mg/mL)	20 mg (1 mL)
Lidocaine ET 2% (20 mg/mL)	40-60 mg (2-3 mL)
1st Defibrillation	40 J
2nd Defibrillation	80 J
3rd Defibrillation	80 J-200 J
Cardioversion 1st/2nd Dose	20 J/40 J
Adenosine (3mg/mL)	
1st Dose	2.1 mg (0.7 mL)

RSI	
PREMEDICATIONS	
Atropine	N/A
INDUCTION DRUGS	
Etomidate (2 mg/mL)	6.3 mg (3.2 mL)
Ketamine (10 mg/mL)	42 mg (4.2 mL)
(50 mg/mL)	42 mg (0.84 mL)
Propofol (10 mg/mL)	63 mg (6.3 mL)
PARALYTIC DRUGS-INITIAL DOSE	
Succinylcholine (20 mg/mL)	42 mg (2.1 mL)
Rocuronium (10 mg/mL)	25 mg (2.5 mL)
PARALYTIC DRUGS-MAINTENANCE DOSE	
Vecuronium (1 mg/mL)	2.1 mg (2.1 mL)

2nd Dose	4.2 mg (1.4 mL)	Rocuronium (10 mg/mL)	25 mg (2.5 mL)
Amiodarone (50 mg/mL)	105 mg (2.1 mL)	**SEDATION DRUGS-MAINTENANCE DOSE**	
Calcium Chloride (100 mg/mL)	420 mg (4.2 mL)	Lorazepam (2 mg/mL)	1 mg (0.5 mL)
Procainamide (100 mg/mL)	315 mg (3.2 mL)	(4 mg/mL)	1 mg (0.25 mL)
(500 mg/mL)	315 mg (0.63 mL)		
Magnesium Sulfate (40 mg/mL)	1050 mg (26.2 mL)		
Magnesium Sulfate (80 mg/mL)	1050 mg (13.1 mL)		

19 KG	20 KG	22 KG

Weight, don't tell me:

Approximate ideal body weight is listed on the bottom of each length-based color zone.

Color-coded weight zones range from 3 kg (i.e., not for preemies) to 36 kg.

The name of the color is printed on the top of each zone (especially helpful for colorblind providers).

One shade of gray: Unlike the other color zones, the 3 to 5 kg weight zone technically doesn't have a color name. However, it's commonly referred to as the "gray zone," not the 3 to 5 kg zone. This zone is for infants from newborn to three months–but not for preemies.

Other means all: In the gray color zone, equipment sizes aren't found. The note referring to other equipment implies all equipment and refers the user to the pink/red zone. The pink/red zones list the suggested emergency equipment sizes. Endotracheal tube insertion length is found in the gray zone, just not the size of the endotracheal tube.

Taping the tube: When you see the term "ET insertion length," or "lip to tip," this implies the location where the endotracheal tube is secured.

WTF (where's the Foley?): Look instead for "urinary catheter"–Foley is a trade name; the generic term is urinary catheter.

WTF #2 (what's the fluid [bolus]?): What many of us would call a fluid bolus is instead listed on the tape as "volume expansion crystalloid: NS or LR." The classic formula of 20 mL per kg is still utilized and the mL dose is listed. You just have to know what to call it in order to find it (in the fluids section). Blood is also conveniently included in the fluids section, as "colloid/blood."

Conclusion

As the Bob Dylan song goes, "The times, they are a changin.'" Just as popular music has changed over the years, the Broselow-Luten tape continues to evolve.

What doesn't change is the need to provide the best care we can in emergencies. When the chips are down and all bets are in, you don't want to be left guessing or stressing. You don't want to be relying on mental math if you don't need to. The tools and resources are out there. You just need to know

what they are, where to find them, and how to use them!

References

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2. Luten R. (June 21, 2018). Personal phone conversation with Robert Luten, MD.

3. Luten R, Zaritsky A. The sophistication of simplicity…optimizing emergency dosing. *Acad Emerg Med*. 2008;15(5):461—465.